# INVESTIGATION 5-D

## Another Test of the Law of Conservation of Energy

**TARGET SKILLS**

- **Predicting**
- **Performing and recording**
- **Analyzing and interpreting**

In Investigation 5-A, you attempted to test the law of conservation of energy by making a prediction involving the transfer of energy from gravitational potential energy into kinetic energy. In this investigation, you will examine the transfer from elastic potential energy into kinetic energy. You will then use the predicted value of kinetic energy to determine the launch velocity of a projectile and, therefore, its range.

### Problem

Does the law of conservation of energy make valid predictions when energy is converted from elastic potential energy into kinetic energy?

### Equipment

- balance
- retort stand
- ramp or small, smooth board
- set of masses with a mass holder
- protractor
- metre stick or metric tape measure
- utility clamp
- small spring
- small cardboard box
- masking tape

**CAUTION** Safety goggles must be worn during this activity.

### Procedure

Work in small groups for the investigation.

1. Measure the mass of the spring.
2. Using the equipment, determine the spring constant for the spring.
3. Set up the ramp on a desk, or make a ramp by resting one end of the board on a stack of books. Measure the angle that the ramp makes with the desktop. Make sure that there is a long stretch of clear space in front of the ramp.
4. Decide on the amount of extension that you intend to use with the spring and then determine the corresponding elastic potential energy stored in the spring at that extension.
5. Set up the spring by hooking one end over the upper edge of the ramp. Then, pull it backward to extend it the selected distance and release it. Use the law of conservation of energy to determine the velocity with which the spring will leave the ramp.
6. Use the velocity and the height of the end of the ramp to determine the point at which the spring will hit the floor (or the wall).
7. Place the cardboard box at that predicted point and perform the launch.

### Analyze and Conclude

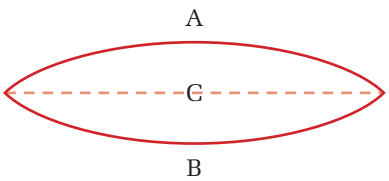
1. Provide a summary of your force-extension measurements for the spring.
2. Show your calculation of the spring constant.
3. What extension did the group choose? Show your calculation of the elastic potential energy stored in the spring.
4. Show your calculation of the
   **(a)** velocity of the spring as it leaves the ramp
   **(b)** range of the projectile (the spring)
5. How close did the spring come to its predicted landing point?
6. Describe the energy changes that occurred during the launch and flight of the spring.
7. Does this investigation further confirm the law of conservation of energy?

### Apply and Extend

8. Spring-loaded dart guns with dart safety tips are available as toys. Decide how you could determine the spring constant and hence the maximum range of the projectile (the dart). If possible, repeat this investigation using one of these toy guns. You might recall from earlier studies that the maximum range occurs when the dart is launched at 45° to the horizontal.

## 5.2 Section Review

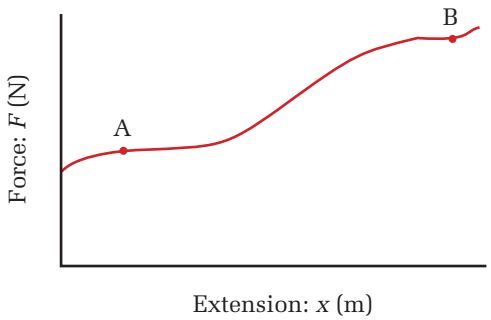
1. K/U Explain how each of the following behave like a spring.
   - **(a)** a pole used in pole-vaulting
   - **(b)** the strings in a tennis racquet
   - **(c)** the string on a bow
2. I Prove that the expression for elastic potential energy has units equivalent to the joule.
3. MC In what way is a spring similar to a chemical bond?
4. MC List three other forms of periodic motion not mentioned in the section.
5. K/U A guitar string is vibrating horizontally, as shown in the diagram. It vibrates between positions A and B, passing through the equilibrium or rest position C. In which positions is the string vibrating with the following?




   - **(a)** greatest speed
   - **(b)** least speed
   - **(c)** greatest kinetic energy
   - **(d)** greatest elastic potential energy

   Give reasons for your choices.
6. MC There are four basic forces in our universe.
   - the weak nuclear force (between particles in the nucleus)
   - the strong nuclear force (between particles in the nucleus)
   - electromagnetic force (between charged particles)
   - gravitational force (between masses)

   Which force is responsible for the potential energy stored in the following?
   - **(a)** a battery
   - **(b)** the water behind a dam
   - **(c)** a stretched spring
   - **(d)** a mound of snow at the top of a slope just before an avalanche
7. I Describe an investigation to determine the force-extension characteristics of an archery bow.
8. C Prepare a diagram to demonstrate the relationships between the gravitational potential energy, and the kinetic energy of the swinging bob in a pendulum.
9. I Given the following graph of applied force against extension, describe a technique for determining the amount of potential energy stored in the object between points A and B.




**UNIT PROJECT PREP**

Once you understand both periodic motion and the conditions necessary to generate it, you will find that periodic motion frequently appears in both natural and manufactured systems.

- Brainstorm to identify systems that experience periodic motion.
- Attempt to formulate an argument supporting an intrinsic link between understanding the periodic transformation of energy and environmentalism.